Chinook Salmon

Chinook salmon are a cultural icon of the Pacific Northwest. Truly the "King" of Pacific salmon, Chinook are the largest species. Adults can exceed 30 pounds, and reports of larger fish were once more common.

Returning Chinook are highly prized by anglers and commercial fisherman and are a favorite food of Orca whales. Puget Sound Chinook return in the summer and fall to spawn, build gravel nests, and lay their eggs in rivers and streams. Their carcasses provide nutrients for freshwater invertebrates which in turn provide food for young fish. As they grow, juvenile Chinook move from freshwater to estuaries and nearshore areas to find food and cover to hide from predators. They eventually move to more exposed shorelines where they depend on eelgrass and kelp beds as they continue their migration to the ocean.

Puget Sound Chinook are about one-third as abundant as they were in the early 1900s and were listed in 1999 as "threatened" under the federal Endangered Species Act.

Chinook Salmon

INDICATOR:

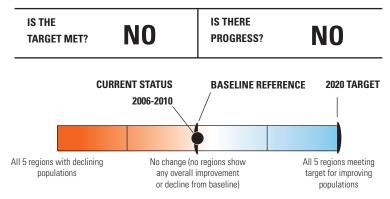
Chinook salmon population abundance as measured by the number of natural origin adult fish returning to spawn

Indicator lead: Recovery Implementation Technical Team

2020 TARGET:

Stop the overall decline and start seeing improvements in wild Chinook abundance in two to four populations in each biogeographic region.

PROGRESS:



From 2006-2010, most Chinook populations showed large annual variability in abundance but no discernable increasing or decreasing trends. Overall, only one population showed an improving trend, and one population showed a declining trend. None of the five regions have yet met their targets for improving population abundance.

Progress Towards Target

For the 22 remaining populations of Puget Sound Chinook salmon, one increased and one declined in abundance from 2006 to 2010. Thus, none of the five regions are currently meeting their target of improving trends in two to four populations in each region.

The total number of Chinook salmon has not increased, and most populations remain well short of their recovery goals. Nonetheless, the fact that we have any natural-origin Chinook left is testament to the success of our restoration and harvest reduction work so far.

What Is This Indicator?

Chinook population abundance is reported here two ways: The number of natural origin spawners and the number of natural origin recruits.

Spawning escapement is the number of Chinook salmon returning to rivers to spawn. Spawner abundance is normally estimated each year by counting the number of redds (gravel nests) in a river. Redds are counted by walking the stream and/or from boats or aircraft. For many populations, some hatchery-origin salmon mix with natural origin salmon on the spawning grounds, complicating our estimates of natural origin salmon returns. The proportion of spawners that were natural or hatchery origin is typically estimated based on the composition of carcasses and then extrapolated back to the total spawning population to estimate the number of natural origin versus hatchery-origin spawners.

The second measure, the total number of natural origin recruits, represents the potential return of adult salmon to the spawning rivers if there were no commercial, subsistence, or recreational harvest affecting them. This is the estimated total number of natural origin adult salmon before human harvest. The numbers of hatchery-origin fish were excluded from both estimates of Chinook abundance.

Interpretation of Data

Chinook populations in Puget Sound exhibit large annual variations in abundance, as well as long-term fluctuations (over ten or more years) that confuse simple evaluations of short or long-term trends in numbers (Figure 1). Long-term natural-origin spawner abundance numbers have shown little progress towards the target, with numbers declining since the early 2000s. In addition, overall productivity and the total number of natural origin salmon recruits have declined according to NOAA. All Puget Sound Chinook populations are currently well below abundance levels (recovery goals)

Abundance of Chinook Natural-Origin Spawners in Puget Sound 1990 -2010

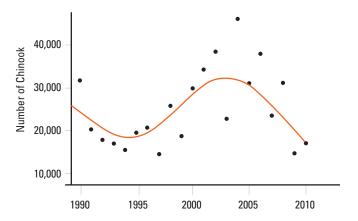
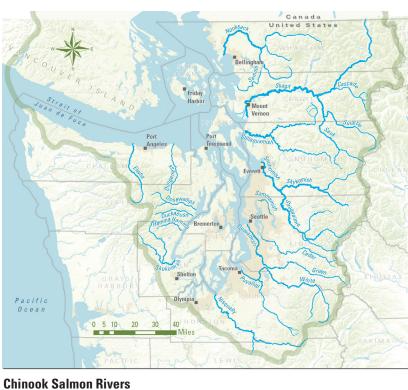


Figure 1. Number of natural-origin Chinook spawners observed in Puget Sound watersheds for 22 populations. Shown are total numbers of natural-origin spawners observed each year (points) and a fitted line derived from locally weighted scatterplot smoothing. Source: NWFSC Salmon Population Summary database



Cities and Urban Growth Areas Salish Sea Basin boundary County border

needed for populations to recover and to reduce their risk of extinction (Table 1). Chinook salmon in Puget Sound are currently listed as Threatened under the Endangered Species Act.

Trends for Chinook recruits were calculated for five- and ten-year periods. For 2006-2010, only two out of 22 populations showed a statistically significant trend. One population increased (Sammamish), and one population (Skokomish) decreased. In contrast, for a ten-year trend analysis from 2001-1010, nine out of 22 populations showed a statistically significant decrease in the number of fish.

SPECIES AND FOOD WEB

Puget Sound Chinook Abundance and Trends

Region/Population	Recovery Goal ¹ Range	Natural-Origin Spawners 5 year average ² (2006-2010)	Natural-Origin Recruits (Spawners + Harvest)		
			5 year average (2006-2010)	5 year Trend ³ (2006-2010)	10 year Trend ³ (2001-2010)
Strait of Georgia					
N Fk Nooksack	3,800 -16,000	274	470		
S Fk Nooksack	2,000-9,100	265	475		
Strait of Juan de Fuca					
Elwha	6,900-17,000	126	282		Decreasing
Dungeness	1,200-4,700	122	336		
Hood Canal					
Skokomish	Unknown	501	863	Decreasing	
Mid-Hood Canal	1,300-5,200	45	78		Decreasing
Whidbey Basin		•			
Suiattle	160-610	219	301		
N Fk Stillaquamish	4,000-18,000	465	803		
S Fk Stillaquamish	3,600-15,000	79	133		Decreasing
Cascade	290-1,200	315	431		
Upper Sauk	750-3,030	584	812		
Lower Sauk	1,400-5,600	620	1,252		
Skykomish	8,700-39,000	2,336	3,081		Decreasing
Snoqualmie	5,500-25,000	1,390	3,013		Decreasing
Upper Skagit	5,380-26,000	8,118	15,134		Decreasing
Lower Skagit	3,900-16,000	1,629	3,252		
Central/South Puget Sound					
White R	unknown	1,216	1,435		Decreasing
Green/Duwamish	27,000	1,311	6,005		Decreasing
Sammamish	1,000-4,000	92	148	Increasing	
Cedar	2,000-8,200	807	1,389		
Nisqually	3,400-13,000	501	3,000		
Puyallup	5,300-18,000	831	1,520		Decreasing

Table 1. Puget Sound Chinook abundance and trends.

¹ High and low productivity planning targets from Table 2 "Chinook Spawner Abundance Planning Targets & Ranges for Puget Sound Region" in Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan. November 2006. National Marine Fisheries Service.

² Averages are geometric means; data from NOAA's Northwest Fisheries Science Center's Salmon Population Summary database.

³ Significance of trends (p < 0.05) was calculated using methods reported in NOAA's Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act (Ford [ed.], 2011).

Freeing the Elwha River

Removing Dams for the Sake of Salmon

The Olympic Peninsula's Elwha River was once one of the richest salmon runs in the Pacific Northwest. All five species of Pacific salmon and other anadromous fish (species that migrate from fresh water to salt water and back again to reproduce) used to spawn in the Elwha by the tens of thousands each year—until two dams built in the early 1900s blocked access to all but the lowest five miles of the river.

Thanks to the largest dam removal project in U.S. history, the Elwha River will soon flow freely from its headwaters in the Olympic Mountains to the Strait of Juan de Fuca, giving salmon access to over 70 miles of river and tributary habitats for the first time in nearly 100 years.

Project Milestones

Two Elwha River restoration milestones have been met in the last year: the completion of the Elwha Dam removal and the partial removal of Glines Canyon Dam, which is expected to be complete next summer. In addition to dam removal, a number of other ancillary projects are underway, including revegetation of the exposed reservoir bottoms, instream habitat restoration, fish restoration, and ecosystem monitoring.

Dam removal is being funded by the National Park Service. Several other agencies and organizations are assisting

missing a key component—anadromous fish. In spring 2012, scientists from the cooperating organizations began transporting adult coho salmon collected at the Lower Elwha Tribe's hatchery and wild steelhead to the pristine waters above the former Elwha Dam site in hopes that these fish would spawn in the wild and help recolonize the river in the future. This along with natural colonization by wild steelhead (early summer) and Chinook salmon (late summer and fall) into the river above Elwha Dam resulted in spawning in areas that haven't seen spawners in 100 years.

and funding associated ecosystem restoration activities,

Fisheries Service, National Oceanic and Atmospheric

Administration Restoration Center, US Fish and Wildlife

Washington Department of Fish and Wildlife (WDFW),

Coastal Watershed Institute, Washington Sea Grant, University of Washington, Peninsula College, and several

others.

Restoring Salmon

Service, US Bureau of Reclamation, US Geological Survey,

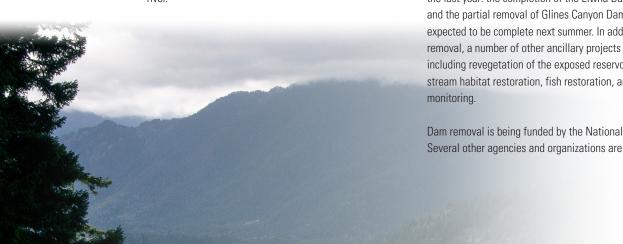
Although the Elwha River and its tributaries above Glines

Canyon Dam were in a natural state, the ecosystem was

including the Lower Elwha Klallam Tribe, National Marine

Fish restoration actions include collecting adult fish as brood stock to seed supportive breeding programs operated by WDFW and the Lower Elwha Klallam Tribe. The programs are designed to help preserve five species of





Freeing the Elwha River

LOCAL STORY

anadromous salmon and steelhead in the river through the dam removal periods when lower watershed conditions will be inhospitable for natural-origin fish production, and assisting in their recovery to a healthier status so that recolonization of newly accessible habitat is accelerated. Other important restoration actions include removing brood stock from sediment-laden river water and moving them to clean water areas upstream of the Elwha Dam site as described above. These fish restoration actions are intended to protect ESA listed species from the high-suspended sediment levels that are expected to be lethal to fish during and shortly after dam removal.

Restoring salmon and other fish species will also increase the productivity of plants and wildlife throughout the watershed. Salmon and steelhead eggs, juveniles, and the carcasses that remain after fish spawn and die are an important part of Pacific Northwest river ecosystems. Salmon bring nutrients from the ocean when they return to spawn. These nutrients are used by hundreds of terrestrial and aquatic animals and provide nutrients for riparian vegetation.

Long-term Benefits

Returning the entire Elwha River to a more natural state will restore one of the largest watersheds on the Olympic Peninsula and provide significant long-term benefits for Puget Sound recovery. More than 80% of this important watershed is located within the protected boundaries of the Olympic National Park and consists of high quality, primarily untouched habitat. Completing the removal of the dams will allow natural sediment transport that will improve river and estuarine habitat quality, reduce nearshore beach and bank erosion, increase intertidal and sub-tidal sediment, and support marine community diversity. Restoring the Elwha River will also assist in the recovery of Elwha River salmon, steelhead, and other key fish species.







Photos from the Elwha Dam removal webcam. Photo Credit: Elwha River Restoration Project



Orcas

Killer whales, also called orcas, are among Puget Sound's most distinctive and charismatic inhabitants. They occupy an important niche at the top of the food web and support a multi-million dollar whale-watching industry.

A unique population of orcas lives in and around the Salish Sea, which includes Puget Sound, the Strait of Juan de Fuca, and the Strait of Georgia. Called the Southern Resident Killer Whales, the community once numbered around 200 whales. In the past decade, the population totaled fewer than 90 individuals.

While other orca populations prey heavily on marine mammals, resident pods primarily eat fish, relying on Chinook salmon for a large part of their diet.

In the late-1990s, Southern Resident Killer Whales experienced a dramatic decline in population size. As a consequence, they were listed as Endangered under the Endangered Species Act in 2006.

Orcas

INDICATOR:

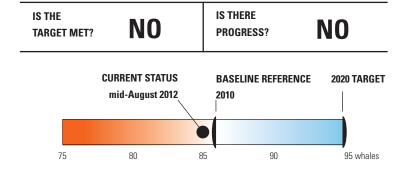
Number of Southern Resident Killer Whales

Indicator lead: Ken Balcomb, Center for Whale Research

TARGET:

By 2020, achieve an end of year census of Southern Resident Killer Whales of 95 individuals, which would represent a 1% annual average growth rate from 2010 to 2020.

PROGRESS:



There were a total of 85 Southern Resident Killer Whales as of mid-August 2012. This was one less whale than the baseline reference of 86 whales.

Progress Towards 2020 Target

The 2020 target of reaching 95 whales has not been met, and in the short-term there has been no progress. Since 2010, the Southern Resident Killer Whale population has never been larger than 88 whales. Furthermore, as of August 2012, the size of the population was smaller by one whale relative to the 2010 baseline reference of 86 whales.

Although there has been no progress made since 2010, the population has been growing, albeit slowly at about 1% per year, over the longer term (1979 to 2010). This population growth trend is consistent with the 2020 target. However, trends could easily be reversed, as the Southern Resident Killer Whale population is very vulnerable to a variety of factors, making progress towards the 2020 target tenuous at best.

What Is This Indicator?

The Southern Resident Killer Whale population in Puget Sound is actually a large extended family, or clan, comprised of three pods: J, K, and L pods. Although they can be seen throughout the year in Puget Sound, they are most often seen during the summer, especially in Haro Strait west of San Juan Island, the Strait of Juan de Fuca, and in the Strait of Georgia near the Fraser River.

Threats to Southern Resident Killer Whales include contaminants, prey availability, vessels, and noise pollution. Additional human activities, such as underwater military activities, have been identified as a potential concern for killer whales, particularly on the outer coast. This issue has not been fully evaluated. Their small population size and social structure put them at risk for a catastrophic event, such as an oil spill, or a disease outbreak, that could impact the entire population.

Resident orcas were chosen as an indicator because they are top-level predators, spend a portion of the year in Puget Sound to feed and socialize, and are threatened by some of the pressures on the Sound, such as pollution and declining salmon and herring runs. Although a robust orca population is an important recovery goal both at the state and federal level, there may be limits to how much the orca indicator can tell us about the overall health of Puget Sound. The Southern Resident Killer Whale population migrates in and out of the area, and thus is not entirely dependent on Puget Sound and its resources.

Interpretation of Data

Current Status and Trend

The census of the Southern Resident Killer Whale population, conducted annually by the Center for Whale Research, is an important method by which to assess the status and trends of this endangered population. The entire population is counted with a high degree of certainty using photo identification techniques. Sighting networks throughout Puget Sound support the census. Two of these networks are showcased elsewhere in this report (please see "Volunteers Gather Important Data on Orcas" on page XX).

Other populations of whales, such as Transients and Northern Resident Killer Whales, also frequent the Salish Sea, but their numbers are not reported here because the indicator and target focus only on Southern Resident Killer Whales.

The population size of Southern Resident Killer Whales changes temporarily throughout the year as whales are born and die. For example, as of the end of 2011 there were 88 Southern Resident Killer Whales in total, with 26 in J pod, 20 in K pod and 42 in L pod (Figure 1). Since December 2011 four

whales have gone missing (J30, K40, L5, L12) and are presumed dead. A fifth missing whale (L112), drifted ashore dead in February on the outer coast of Washington. However, two new calves (J49, L119) have been seen since the beginning of 2012 such that, at the time of publication, there were 85 Southern Resident Killer Whales in Puget Sound.

Thus, abundance did not change significantly in the last decade (Figure 1). However, although there has been no progress in the short term, analysis of historic data shows modest growth.

Historic Trends

Since data became available in 1973, the Southern Resident Killer Whale population has by turns declined and grown. Despite year-to-year variability, total population size grew over the past four decades by about 1% per year: there were fewer than 70 whales in the early 1970s, and an annual average of 85 whales in the 2000s (Figure 1). Yet, compared to the Northern Resident Killer Whale population living in the Strait of Georgia, the Southern Resident Killer Whale population is smaller and has been growing more slowly overall.

At the pod level, the long-term population growth rate (from 1979 and 2010) is slightly lower for J and K pods combined (~2%) than for L pod (~1%). L pod is the largest of all pods. However, this pod has been in decline since the early 1990s.

The other two pods, J and K, are roughly the same size. Both J and K pods are growing, with J pod increasing more rapidly than K pod. This is likely due to the limited reproductive potential in K and L pods. Indeed, the sex ratio of K and L pods is skewed toward males. The lack of reproductive females, poor survival of calves, and factors associated with small population sizes such as inbreeding, along with human-caused threats, are a concern for the viability of this population.

Orcas

J pod is also the pod that spends the most time in Puget Sound compared to the other two. The fact that Southern Resident Killer Whales only spend part of their lives in Puget Sound, and that the pod that spends the least time in Puget Sound has the steepest decline, suggests that the whales are impacted by conditions outside of Puget Sound.

Although the Southern Resident Killer Whale population's long-term trend for population growth meets the growth rate target, the population growth rate does not meet the legal recovery criteria to delist the Southern Resident Killer Whales from the Endangered list (i.e., meeting an average growth rate of 2.3% per year for 28 years).

Restoration of this population of long-lived, slow-reproducing killer whales is a long-term effort that requires cooperation and coordination of West Coast communities from California to British Columbia. It will take many years to fill key data gaps and assess the effectiveness of ongoing recovery actions for the whales, salmon, and their habitat, and to observe significant increases in the Southern Resident population.

Number of Southern Resident Killer Whales in Puget Sound *Annual, 1972-2012*

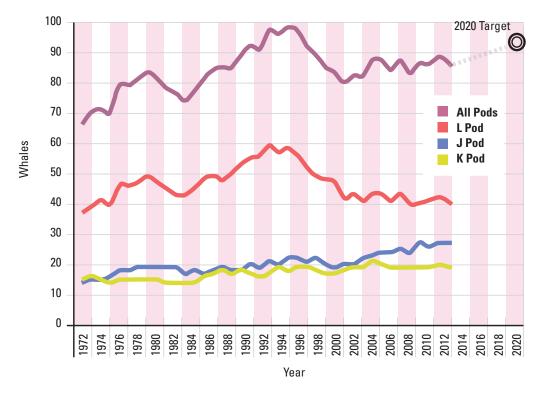


Figure 1. Number of Southern Resident Killer Whales in Puget Sound each year between 1972 and 2012. *Source: Center for Whale Research*

Volunteers Gather Important Data on Orcas

LOCAL STORY

Salish Sea Hydrophone Network and Orca Network

The Salish Sea Hydrophone Network and Orca Network are two citizen science projects dedicated to furthering our understanding of abundance, distribution, behavior, and habitat use by the endangered population of Southern Resident Killer Whales, also called orcas. The Hydrophone Network lets the public listen for orcas through their computers and phones, while the Orca Network gathers and disseminates sightings of orcas as they move between Puget Sound, the Fraser River, and the Pacific Ocean.

Listening in on Orcas

The **Salish Sea Hydrophone Network** started in 2007 and now includes five hydrophones (underwater microphones): two on San Juan Island, and one each at Port Townsend Marine Science Center, the Seattle Aquarium, and Neah Bay. By monitoring the sounds streaming live on orcasound.net, scientists, educators, and the public can help detect loud calls and clicks made by orcas as they communicate and hunt. Listeners can also help detect noise pollution caused by Naval sonar and vessel traffic.

For orcas and other whales, the underwater sound environment is critical to their sensory experience and behavior. Orcas communicate with each other over short and long distances with a variety of clicks, chirps, squeaks, and whistles. They also use echolocation to locate prey and to navigate.

Hydrophone Network volunteers log their observations on a collaborative Google spreadsheet online or report detections via email. Volunteer observations help to direct field research, including prey sampling studies that revealed the orcas strong preference for Chinook salmon and fecal sampling studies that show orcas may be prey-limited. In addition, the hydrophone network enabled early detection of a new orca calf in 2009.

The Network allows friendly competition and collaboration between volunteer listeners and computers. In detecting

when orcas passed by a proposed tidal turbine site near Port Townsend, human listeners heard the orcas 10 of the 22 times they passed by (45%) while auto-detection software detected them 14 times (64%). When both approaches were combined orcas were detected 17 times (77%).

The number of orcasound.net visitors per day rises from a mid-winter low of about ten to a summertime average of approximately 100, with occasional spikes to 200-350. Listeners are predominantly from the U.S. (75%) and Canada (13%), so observers from distant time zones are sought to boost nighttime detection rates.

Watching for Orcas

Given the wide-ranging travels of the Southern Resident Killer Whales and other whales in the Salish Sea, it is impossible for the few whale researchers to track all the individuals on a regular basis.

Orca Network's Whale Sighting Network

was started in 2001 to provide more information on Southern Resident Killer Whale travels in inland and coastal waters. In addition, the network also raises awareness, educates the public, and provides a networking and communication system for researchers, educators, and the public. There are currently more than 7,000 participants on the Sighting Network email list, and more than 14,000 subscribers to the Facebook page.



Lime Kiln Hydrophone. Photo Courtesy of Dave Howitt

Volunteers Gather Important Data on Orcas

LOCAL STORY

With more than 15,000 sightings reported to date by the hundreds of participants in the Sighting Network, Orca Network harnesses broad public interest in whales to provide researchers with critical information for tracking these endangered whales.

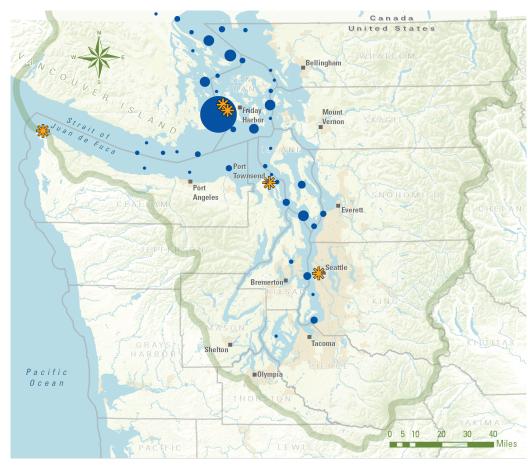
Through the Sighting Network, volunteers report sightings of whales, which provide valuable information on habitat use, social and foraging patterns, and behaviors for researchers managing the recovery of Southern Resident Killer Whales. Reports are compiled and sent to researchers, natural resource managers, and educators and are available on the Orca Network website, Facebook page, and Twitter feed.

The Sighting Network also provides an important communication and tracking tool during emergency situations such as oil spills and entangled whales. It also helps identify orcas out of their usual habitat, such as Springer, the Northern Resident orca calf who was reported through the Sighting Network in Swinomish Channel, then off Edmonds, before showing up off Vashon Island. She was relocated to her home in Canadian waters in 2002.

More information about the Salish Sea Hydrophone Network and the the Orca Network's Whale Sighting Network can be found at:

www.orcasound.net | www.orcanetwork.org

Figure 1. Salish Sea Hydrophone Network locations and 2011 orca sightings from the Orca Network Whale Sightings Network. Orca sightings data were compiled from monthly sighting maps and include only orca (resident or unknown) reports and only one report per location per day (although it is possible that the Network received more than one report per location per day). Source: Salish Sea Hydrophone Network and Orca Network



Whale Sightings Networks





Pacific Herring

INDICATOR:

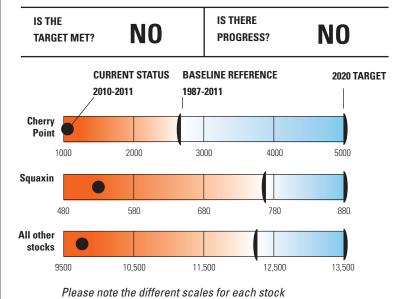
Biomass of Spawning Pacific Herring

Indicator lead: Kurt Stick, Washington Department of Fish and Wildlife

TARGET:

Increase the overall amount of spawning herring throughout Puget Sound to about 19,000 tons. For each stock, the targets are: Cherry Point: 5000 tons; Squaxin Pass: 880 tons; all other stocks: 13,500 tons.

PROGRESS:



The spawning biomass of all herring stocks remain below their target values as well as their baseline reference, which is defined as the 25-year mean from 1987 to 2011.

Progress Towards 2020 Target

None of the 2020 target values for individual Pacific herring stocks or groups of stocks are met, and no progress has been made. Instead, the current spawning biomass of all stocks are below both their 25-year mean baseline reference and their 2020 target values (Figure 1).

The Cherry Point herring stock in North Puget Sound, once the largest stock in the Sound, has declined by 90% since the earliest sampling date in 1973 and shows little sign of recovery.

The Squaxin Pass and other Puget Sound stocks do not exhibit the sharp decline seen in the Cherry Point stock. Although they show broad annual fluctuations, these stocks are relatively closer to their target values. In fact, in some years, these stocks have gone above their target values. However, these stocks are currently at biomass levels below their target values (Figure 1).

Predicting the future condition of herring spawning biomass is difficult. Owing simply to natural fluctuations in abundance, the Squaxin and other Puget Sound stocks in Central and South Puget Sound may reach their respective target values again over the next eight years. However, there is no evidence to suggest that herring spawning biomass at Cherry Point will increase and reach its target value by 2020, or that the biomass of all other stocks will be sustained at or above their target values. Although potential threats have been identified, there is no consensus on which threats limit the stocks or how best to manage these stocks to achieve the 2020 target.

What Is this Indicator?

The spawning biomass of Pacific herring is the estimated annual tonnage of spawning herring in Puget Sound. Herring spawning biomass is currently based on spawn deposition surveys conducted by the Washington Department of Fish and Wildlife (WDFW) to estimate the quantity of eggs deposited by herring on marine vegetation. Egg abundance is then converted to the estimated biomass of spawning herring. As measured, the indicator only reflects the status of reproductive fish rather than the status of the entire population because younger, immature age classes do not spawn.

Reflecting genetic studies that have identified three separate groupings of Puget Sound herring stocks (Figure 2), the Partnership has established three separate targets for Cherry Point, Squaxin Pass and all other stocks combined. Estimates of spawning biomass have been attempted for all known Puget

Sound herring stocks by WDFW annually since 1996, and for Cherry Point herring since the early 1970s. The baseline references, the 25-year mean biomass for each stock (1987 – 2011), are intended to provide perspective for the current status of each stock (the 2-year mean of 2010 and 2011) and the targets. The baseline reference and evaluation of current stock status reported here are not based on a conventional fishery stock assessment, which takes into account growth, maturity, fecundity, and mortalities.

Spawning Biomass of Pacific Herring Stocks in Puget Sound

In tons, 1973 - 2011

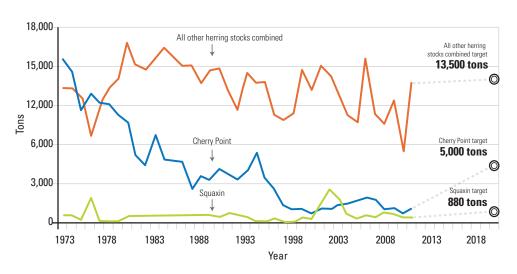


Figure 1. Annual estimates of Puget Sound herring spawning biomass, by genetic grouping with associated targets (1973 to 2011).

Source: Washington Department of Fish and Wildlife, Fish Program

Pacific Herring

Interpretation of Data

The Puget Sound herring data are characterized by broad year-to-year fluctuations, which is typical of Pacific herring populations and likely reflects natural environmental and demographic variability. Indeed, in Puget Sound, the bulk of the biomass of the "all other stocks" grouping is contributed by different stocks in different years, further implicating the role of site-specific variability.

The exact causes of the Cherry Point decline are unknown, but it has been variously attributed to many potential factors such as chronic pollution (e.g., PCB and PAH contaminants), oil spills, overfishing, parasites, disease and changes in abundance of predators or prey. Changes to the natural shoreline, including nearby industrial construction and operation, also may play a role. Finally, the extent to which food-web interactions may limit herring populations, and how such interactions are mediated by the effects of climate change, are not well understood. Further studies are needed to elucidate the effect of these possible pressures.

Several factors contribute to difficulties in understanding Cherry Point stock declines and in the trends of other herring stocks, including survey methods and exploitation rate analysis.

Since 1973 at Cherry Point and 1986 for the rest of the stocks, WDFW has conducted a combination of spawn deposition surveys and Acoustic-Trawl (AT) surveys to estimate herring spawning biomass. Until 1996, the spawning biomass of the larger Puget Sound stocks typically was assessed by both methods each year while the smaller stocks were surveyed by spawn deposition surveys every three years. Since 1996, the spatial coverage of both survey methods has been progressively reduced until the AT surveys were finally discontinued in 2009 due to budget reductions. Spawn deposition surveys and AT surveys each have their advantages depending on the size and type of substrate for eggs, therefore work at their best when used together.

In addition to spawning biomass, biological samples used to estimate growth, mortality, and recruitment were obtained from the AT surveys. These data which are not currently being collected, are useful for assessing the stocks' population dynamics and capacity to meet the targets, and to understand the mechanisms driving these trends.

For example, for the Cherry Point and most other Puget Sound stocks, there has been a shift in the age structure of the population since the late 1970s and early 1980s towards younger fish, which probably affected their productivity and slowed down their recovery.

As mentioned above, not all spawning grounds/stocks have been surveyed every year. To complete the time series depicted in Figure 1, data gaps were filled in with the long-term average for the stocks with missing data. Given the importance of this indicator to the recovery of the Sound, monitoring methods and analysis should be reviewed and improved to more completely and accurately report status and trends.

Commercial exploitation of Puget Sound herring is limited to a bait fishery, which is allowed to take up to 10% of the cumulative Puget Sound spawning biomass of Central and South Puget Sound stocks. Landings in the past 10 years have ranged from 3 to 5% of this total and are not expected to increase significantly in the near future. This is a conservative exploitation rate, compared to a typical global exploitation rate of 20%. Although a 10% exploitation rate is precautionary, a more rigorous analysis of an appropriate exploitation rate, that accounts for current population dynamics (including age composition) and ecosystem needs (e.g., the extent of predator dependency on forage fish), is desirable to ensure sustainability of the Puget Sound herring stock.

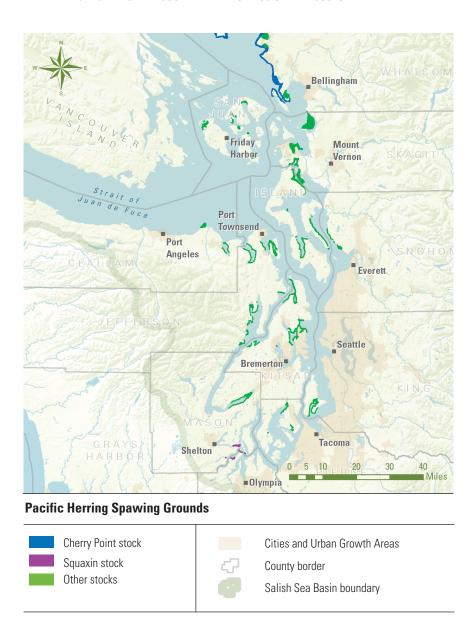


Figure 2. Distribution of Pacific herring spawning grounds in Puget Sound. *Source: Washington Department of Fish and Wildlife, Fish Program.*

Birds

A large community of aquatic and terrestrial bird species depend on Puget Sound's watershed for survival. Walk along the shores of Boundary Bay in any season, and you'll see an ever-changing cast of birds. Thousands of seabirds, seaducks, and waterfowl migrate from all directions to converge in the relatively calm and food-rich waters of Puget Sound each winter. In summer, colonies of seabirds are busy attending their young. In spring and fall, the shorelines are full of shorebirds that stop to feed and rest during migration.

Birds serve as useful indicators of ecosystem change and ecosystem health. The Partnership is currently working with the Washington Department of Fish and Wildlife, U.S. Geological Survey, and the Puget Sound Ecosystem Monitoring Program's Birds and Mammals workgroup to develop a meaningful marine and terrestrial bird indicator and potential targets to help achieve its recovery goal of healthy and sustaining populations of native species. Upon completion later this year, the Science Panel and Leadership Council will review the recommendations and make final decisions on the indicators and targets.



